

## Dispersion Measurements 7/15/2004

Dispersion is a statistical measure of the angular distribution of the magnetic domains in a thin-film anisotropic sample. It is measured in units of degrees. Imagine a histogram plot of the angular distribution of the domains, with angle as the X-axis, and number of domains as the Y-axis. Dispersion is a measure of the width of this distribution curve, again in units of degrees. As with any distribution curve there are varying measures of the width of the distribution – in this case the most common choices being dispersion 50% and dispersion 90%.

The Shb Magnetic Measurements Systems measure two dispersion using two different methods, known as DispS and DispK. Each can be measured at the 50% or 90% point. For a given sample DispS and DispK will typically give somewhat different values, but will tend to track each other over a range of samples.

### DispS (“Skew Method”)

The sample is aligned to the Easy axis, using Norm pickup and Norm field. The field is then changed to Tran, which results in an approximately flat line if the sample is exactly aligned to the Easy axis. If the sample were now to be rotated away from the Easy axis, the flat line would change into a pattern with a two “bumps” in the center of the display, one going up and one going down. If the sample is continued to be rotated until the height of the bumps is equal to either 50% or 90% of the previously measure Bs value, then one could use a protractor to measure the number of degrees of sample rotation that were necessary. This number of degrees would then be reported as DispS 50% or DispS 90% (also known in the literature as alpha 50 or alpha 90). This was the approach used by older Shb instruments. Current production instruments use the same setup, but instead of physically rotating the sample, the direction of the applied field is changed instead. Specifically, we begin in the state of the flat line display, with only Tran field applied (at an amplitude of Htran). The direction of the field is slowly changed by applying increasing amounts of in-phase Norm field (Hnorm), until the “bumps” reach the desired height. The DispS value that is reported is the angle of the field from the Tran axis, calculated as  $\arctan(H_{norm}/H_{tran})$ .

### DispK (“Hk Method”)

The sample is again aligned to the Easy axis, using Norm pickup and Norm field, and the field is then changed to Tran, which results in an approximately flat line if the sample is exactly aligned to the Easy axis. Rather than slowly apply in-phase Norm field as is done for DispS, we slowly apply 90 degree out of phase Norm field, resulting in a rotating field, with a full amplitude Tran component, and a slowly increasing 90 degree out of phase Norm component (Hnorm). The Norm component of the rotating field is increased until the bumps reach 50% or 90% of Bs. The DispK value (in degrees) that is reported is calculated as  $\arctan(H_{norm}/H_k)$ , where Hk was previously measured with the sample aligned to the hard axis.